

# (12) United States Patent

## Kwatra et al.

DETECTION

## (54) LEARNING HIGHLIGHTS USING EVENT

(71) Applicant: Google LLC, Mountain View, CA (US)

(72) Inventors: Vivek Kwatra, Santa Clara, CA (US); Ullas Gargi, Los Altos, CA (US); Mehmet Emre Sargin, Mountain View,

CA (US); Henry Hao Tang, Mountain

View, CA (US)

(73) Assignee: Google LLC, Mountain View, CA (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35

U.S.C. 154(b) by 133 days.

(21) Appl. No.: 15/656,566

(22)Filed: Jul. 21, 2017

**Prior Publication Data** (65)

> US 2017/0323178 A1 Nov. 9, 2017

## Related U.S. Application Data

- Continuation of application No. 14/585,075, filed on Dec. 29, 2014, now Pat. No. 9,715,641, which is a continuation of application No. 13/314,837, filed on Dec. 8, 2011, now Pat. No. 8,923,607.
- Provisional application No. 61/421,145, filed on Dec. 8, 2010.
- (51)Int. Cl. G06K 9/00 (2006.01)G06K 9/62 (2006.01)G06N 20/00 (2019.01)G06K 9/46 (2006.01)
- (52) U.S. Cl.

G06K 9/6256 (2013.01); G06K 9/00536 CPC ...... (2013.01); G06K 9/00724 (2013.01); G06K

US 10.867,212 B2 (10) Patent No.:

(45) **Date of Patent:** Dec. 15, 2020

> 9/46 (2013.01); G06K 9/4647 (2013.01); G06N 20/00 (2019.01); G06K 2009/00738

Field of Classification Search

CPC ...... G06K 9/6256; G06K 9/00536; G06K 9/4647; G06K 9/46; G06K 9/00724; G06K 2009/00738; G06N 20/00

See application file for complete search history.

#### (56)**References Cited**

## U.S. PATENT DOCUMENTS

			Chang et al. Ratakonda	G11B 27/034 715/723
6,072,542	A	6/2000	Wilcox et al.	
6,744,922	В1	6/2004	Walker	
6,754,389	В1	6/2004	Dimitrova et al.	
6,763,069	В1	7/2004	Divakaran et al.	
(Continued)				

## OTHER PUBLICATIONS

Li et al., "A Hidden Markov Model Framework for Traffic Event Detection Using Video Features", In International Conference on Image Processing, Oct. 24-27, 2004, pp. 1-7.

(Continued)

Primary Examiner — Aaron W Carter (74) Attorney, Agent, or Firm — Byrne Poh LLP

#### **ABSTRACT** (57)

A highlight learning technique is provided to detect and identify highlights in sports videos. A set of event models are calculated from low-level frame information of the sports videos to identify recurring events within the videos. The event models are used to characterize videos by detecting events within the videos and using the detected events to generate an event vector. The event vector is used to train a classifier to identify the videos as highlight or non-highlight.

## 21 Claims, 5 Drawing Sheets

